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finally we have species which exhibit complete incompatibility by refusing to cross with one another. The range includes many intermediate conditions like those found in *Crepis*, which nearly approach complete incompatibility. The cross between *H. vulgare* and *H. muranum*, then, is well down the scale and can be grouped in the class with the two species of *Crepis* as showing nearly complete incompatibility.

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#### NOTATIONS

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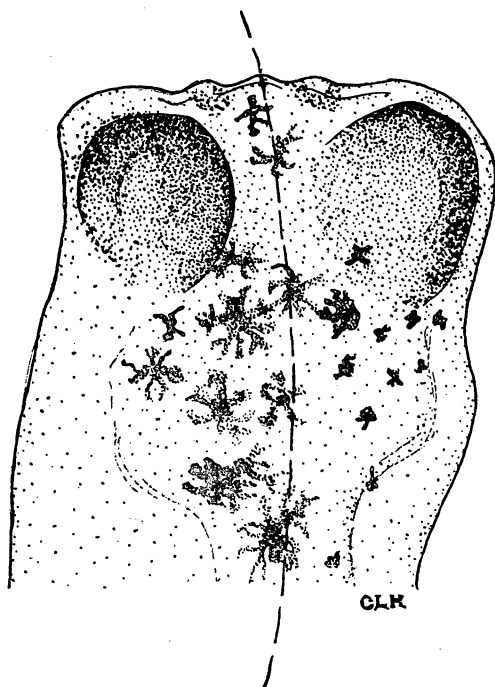
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#### A NOTE ON UNILATERAL REACTIONS OF THE MELANOPHORES OF THE HEAD IN FISHES

IN most discussions of the physiology of the chromatophores of fishes it is apparently assumed that the reactions are strictly bilateral, *i.e.*, synchronous on the two sides. The writer, however, has lately observed a number of cases in which the reaction was either unilateral or imperfectly bilateral.

Upon death, the melanophores of one side of the head in some cases become all "contracted" to the extreme, while those of the other side become widely "expanded." As a result, one side of the head becomes very pale, the other side blackish, the two areas being abruptly opposed along the mediodorsal line. This notable

color change at death has been observed by the writer in an adult pike (*Esox lucius*); in a young-of-the-year of the shiner (*Notropis cornutus*); and in embryonic and larval whitefish (*Coregonus clupeaformis*) and lake-herring (*Leucichthys ontariensis*).



Dorsal Aspect of Head of an Embryonic Whitefish (*Coregonus*), to Illustrate the Unilateral Reaction of the Melanophores.

This phenomenon is not confined to death, however, as the following observations demonstrate. A nuptial male of *Pimephales notatus* (a minnow in which the head becomes densely charged with black pigment during the breeding and nesting activities), apparently normal in respect to its eyes and other structures and functions, found guarding its eggs, had one side of the head abruptly pale. Similarly embryonic and larval coregonine fishes were repeatedly observed to have the melanophores expanded only on one side of the head during life. In the case of the male *Pimephales*, no change in the pigmentation of the head was noted while the fish was being observed for several minutes, nor upon its capture, death or preservation.

In other cases the unilateral reaction of the melanophores was less permanent, appearing as a transient phenomenon; due perhaps, to a differential reaction rate of the chromatophores of the two sides. Two experiments<sup>1</sup> illustrative of this point may be cited.

1. A live, normal, apparently healthy embryo of the lake whitefish (*Coregonus clupeaformis*), developed approximately to the hatching stage, was found to have the dorsal melanophores considerably "expanded" on the head, slightly expanded on the body. Following the removal of the egg envelope, under approximately unchanged conditions, these color-cells "contracted" in this order: (1) body, (2) left side of head, (3) right side of head. Still under similar conditions, the cephalic melanophores again expanded, those of the left side most widely. No further change could then be induced, even by rather intense light-heat stimulation, until the left eye was dissected out and the embryo again held before the light. Reaction occurred at once only on the left (now the blinded) side, the lateral melanophores contracting more rapidly and more completely than the inner ones; as in the first instance, reaction followed (some time after the removal of the stimulus) on the right side, the melanophores contracting in the same order as on the left side.

2. A similar embryo of the same species had the dorsal melanophores of the head well expanded when removed from its egg envelope. The pigment granules of all melanophores on the right side then rapidly migrated into the center of the cells, under observation. No reaction occurred on the left side, even following stimulation with a bright light, although this caused first a partial contraction and then a re-expansion of the right chromatophores. Reaction on both sides was finally accomplished by sudden transfer of the eggs from water near room-temperature (about 25°) to water at 1.7° C., but even in this case the contraction was more complete and rapid on the right than on the left side.

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<sup>1</sup> These experiments were incidental to other studies which the writer carried on during the winter of 1919-1920 in the bionomics laboratory of the University of Chicago; he desires to thank Doctors Lillie and Bellamy of that institution for the opportunity they kindly afforded him to do this work.